BioGas Project Applications for Federal Agencies and Utilities

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BioGas Project Applications for Federal Agencies and Utilities

Objective

- Show means and methods to maximize the use of BioGas.

Excluded

- Production of BioGas
- Political Aspects of Renewable Energy

BioGas - Definition

- produced by the biological breakdown of organic matter in the absence of oxygen;
- produced “on purpose”;
- main source are purpose-grown plants, so called “energy plants” (mostly corn).

Digester Gas (DiG) - Definition

- basically the same origin as BioGas (biological breakdown of organic matter in the absence of oxygen);
- typically a by-product of the treatment of (human) waste water or (animal) manure.

LandFill Gas (LFG) - Definition

- results from chemical reactions and microbes acting upon the waste as the putrescible materials begin to break down in the landfill;
- rate of production is affected by waste composition and landfill geometry, which in turn influence the bacterial populations within it, chemical make-up, thermal characteristics, entry of moisture and escape of gas.

Composition of BioGas, DiG, LFG

- All three gases consist mostly of Methane (CH_4) and Carbon Dioxide (CO_2).
- Small amounts of
  - H_2S (Hydrogen Sulfide
  - NH_3 (Ammonia)
  - H_2O (Water)
  - N_2 (Nitrogen)
  - O_2 (Oxygen)
  - H_2 (Hydrogen)

Composition of BioGas, DiG, LFG

BioGas

- BioGas is (chemically) the “cleanest” of the three gases.
- Almost equal amounts of CH_4 and CO_2 typically account for over 99% of the volume.

Composition of BioGas, DiG, LFG

Digester Gas (DiG)

- DiG may have up to 10% of Nitrogen (N_2), and small amounts of Hydrogen (H_2), Hydrogen Sulfide (H_2S), and Oxygen (O_2).

Composition of BioGas, DiG, LFG

Landfill Gas (LFG)

- Landfills can contain all kinds of household and industrial waste;
- LFG is therefore typically considered the “dirtiest” of the three gases;
- of the three gases, LFG has typically the greatest variation of its heating value.

Comparison of Heating Values

- BioGas, DiG, and LFG
  have almost identical heating values.
- Approximately one-half the heating value of NatGas.
  - NatGas : ~1000 BTU/cuft
  - BioGas : ~550 BTU/cuft
  - DiG : ~640 BTU/cuft
  - LFG : ~550 BTU/cuft

Uses for BioGas, DiG, LFG

(from here on out, DiG and LFG are also referred to as BioGas)

- Can be used wherever NatGas is used.
- Not directly interchangeable with NatGas.
- Requires modification of combustion equipment to accept the low-BTU BioGas.
- No easy “back-and-forth” between BioGas and NatGas.
- No “BioGas in the morning; NatGas in the afternoon”.

Limitations for the use of BioGas (1)

Production

- BioGas production is typically a steady process.
- BioGas is therefore not a good source for “domestic” applications with varying consumption throughout the day (hot water for showers in the morning; low consumption during the day; cooking and heating in the evening; distinct peaks two or three times a day).
- BioGas is today mostly used for electric generators (both reciprocating engines and turbines), which have a constant gas consumption.

Limitations for the use of BioGas (2)

Lack of Storage Part 1 Pipeline Pressure

- BioGas cannot easily be stored.
- Best way to store the excess gas is in the distribution network by compressing the excess gas and allowing the pressure in the pipes to rise.
- This is, of course, only practical up to a certain point.

Limitations for the use of BioGas (3)

Lack of Storage Part 2 Load Variation

- Adjust the consumption to the available gas volume by staging multiple generators.
- If consumption elsewhere is low, operate more generators; if more gas is consumed elsewhere, reduce the number of generators.
- Impossible to exactly match production and consumption.
- Excess gas must be flared off.

Limitations for the use of BioGas (4)

Lack of Storage Part 3.1 mission-critical

- Inability to store large volumes of BioGas rules out mission-critical installations.
- Mission-critical installations must be able to draw from large reservoir – for example the national NatGas grid.

OR

Limitations for the use of BioGas (5)

Lack of Storage Part 3.2 mission-critical

- Produce BioGas at the highest expected flow rate and flare off excess gas.
- Waste of energy, but still widely used.

OR

Limitations for the use of BioGas (6)

Lack of Storage Part 3.3 mission-critical

- Develop method to supplement BioGas with another gas that is directly compatible and interchangeable with BioGas.
- Method would use 100% of available BioGas.
- Method could replace 100% of the BioGas.
- Method would make BioGas acceptable for mission-critical installations.

Source of Supplemental Gas (1)

- Energy in BioGas is CH_4.
- Other CH_4-containing mainstream gas is NatGas.
- Dilute NatGas with air to reduce heating value.
- After dilution, no noticeable differences in combustion characteristics.
- Installations with existing NatGas backup systems can use their SNG as feedstock for the supplemental gas.

Source of Supplemental Gas (2)

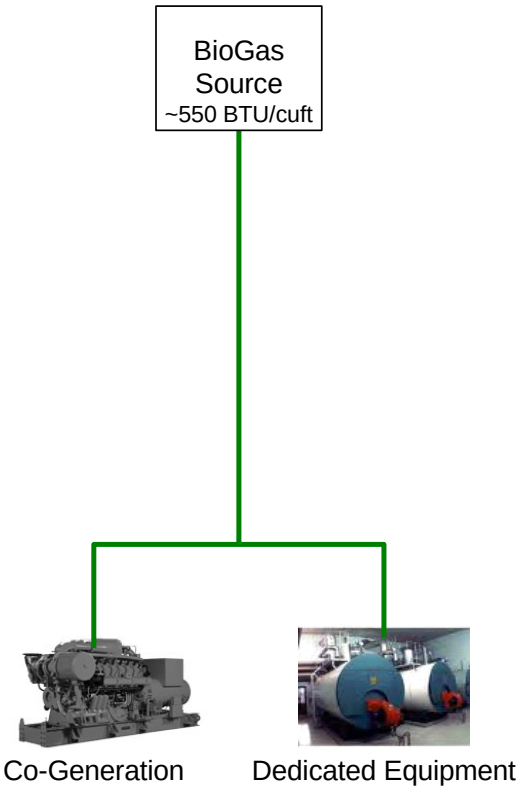
- With such a system in place, the restrictions for using BioGas in mission-critical installations disappear entirely.

- BioGas becomes a viable source for renewable energy.

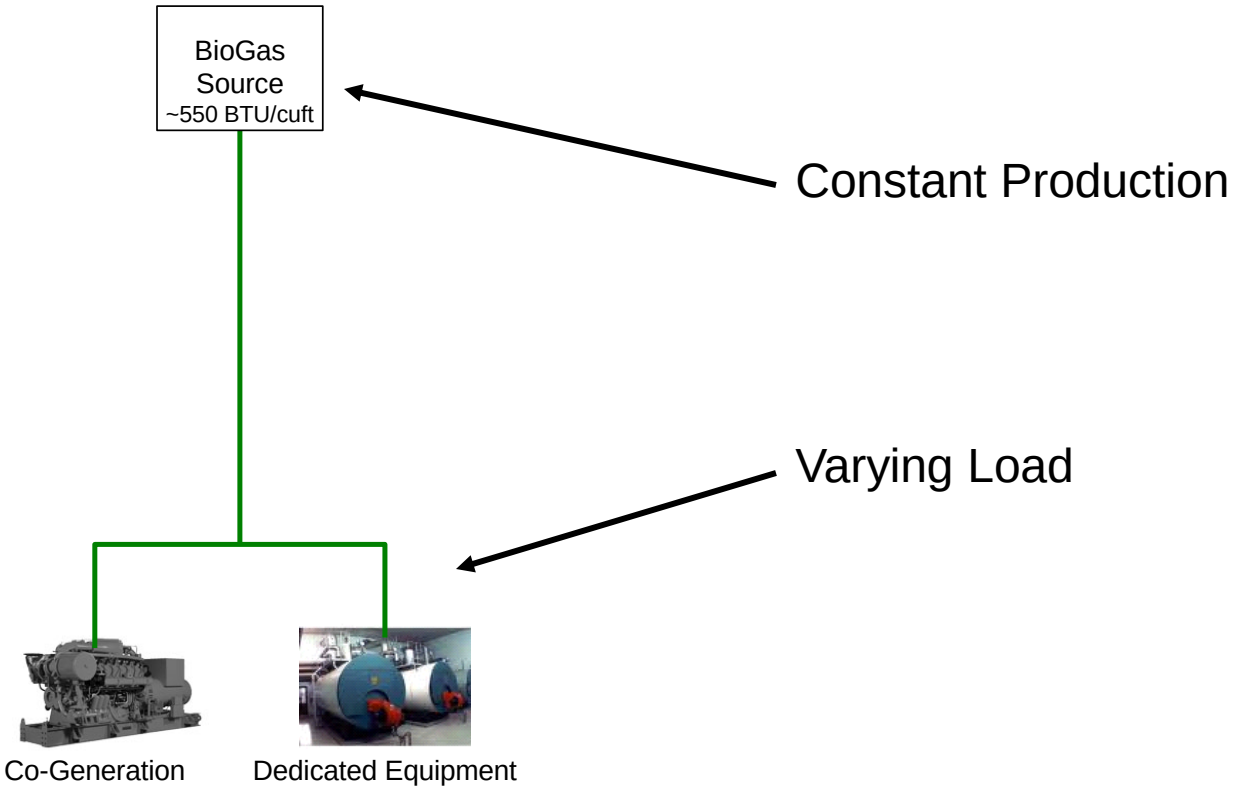
Source of Supplemental Gas (3_1)

BioGas Source
~550 BTU/cuft

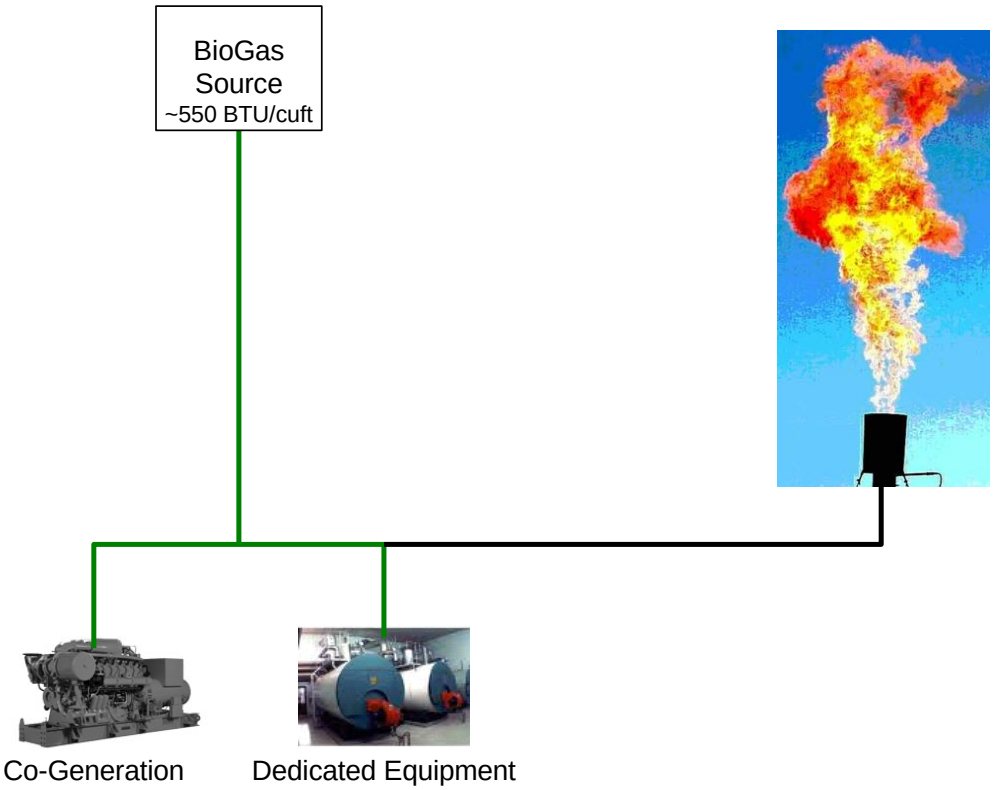
Source of Supplemental Gas (3_2)



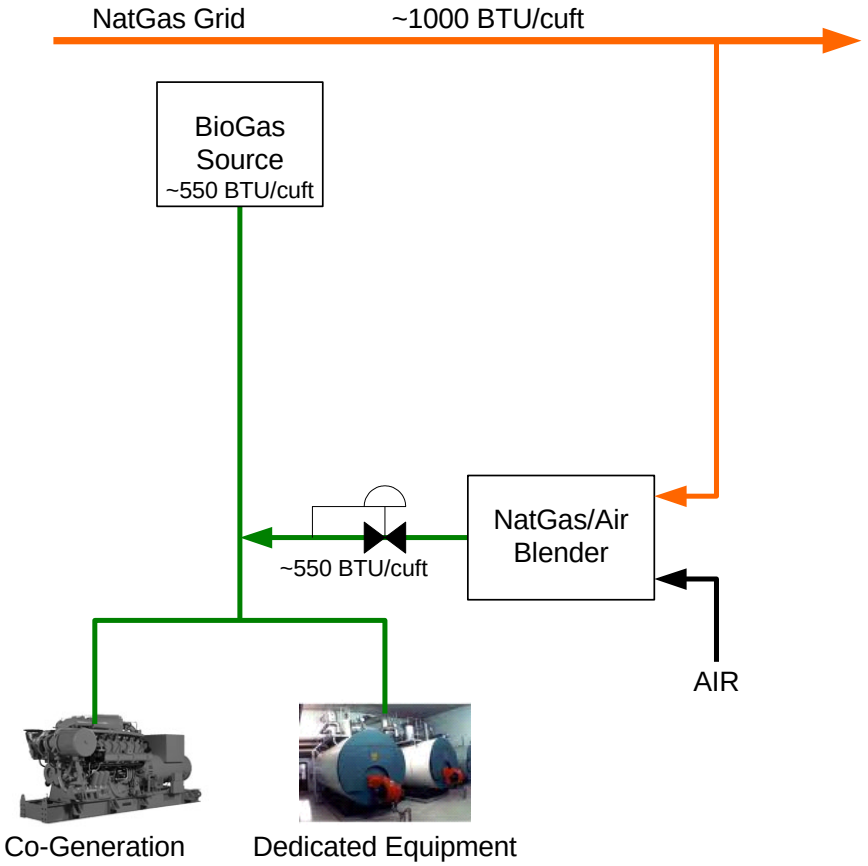
Source of Supplemental Gas (3_3)



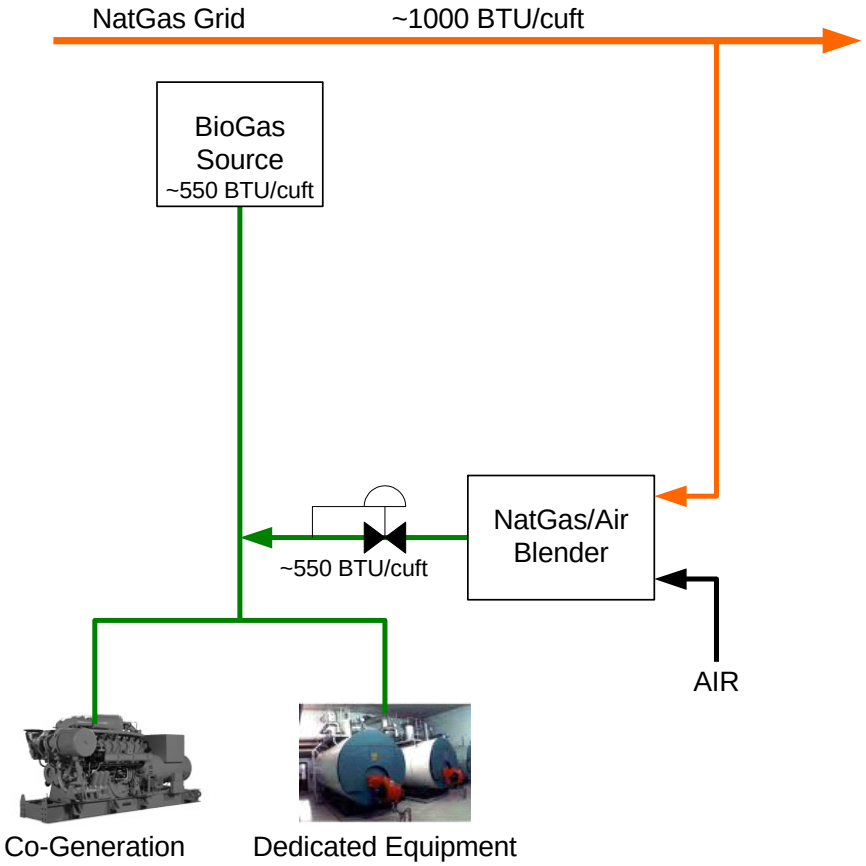
Source of Supplemental Gas (3_4)



Source of Supplemental Gas (3_5)

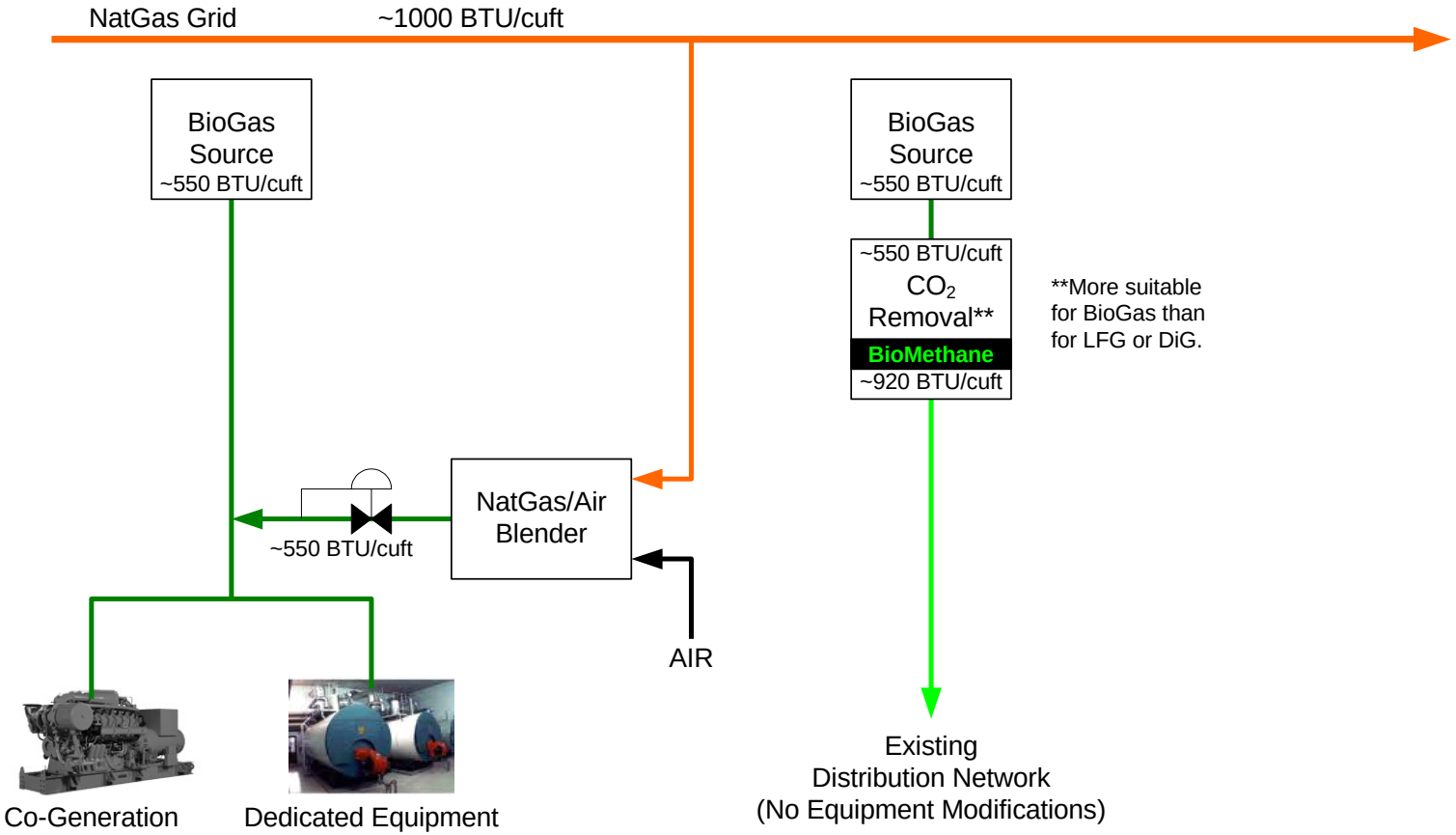


Source of Supplemental Gas (3_6)

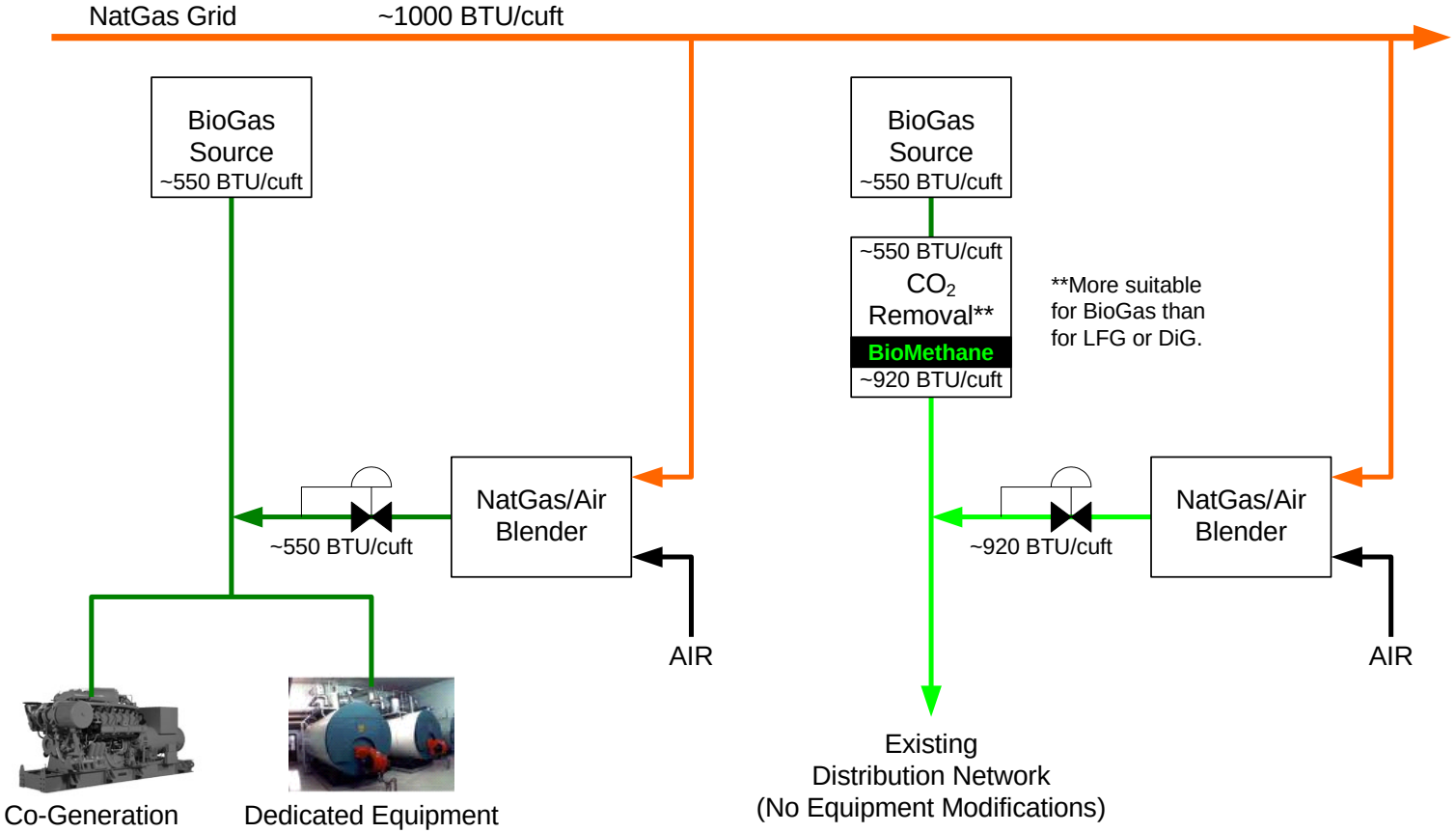


- Covers Demand Peaks
- Automatic Operation
- Can supplement 1-100%
- Still Requires Equipment Modifications

Source of Supplemental Gas (3_7)



Source of Supplemental Gas (3_8)



New Opportunities (1)

- Do you have a landfill nearby?
- Does the landfill have a flare going 24/7 to burn off LFG?
- See if you can tap into that gas source.

New Opportunities (2)

- Do you operate your own waste water treatment plant?
- Do you have to flare off excess DiG because it's just short of being "enough" to run another generator or aerator?
- See if you can tap into that gas source.

New Opportunities (3)

- How many government installations are surrounded by arable land that could (and already does) produce the feedstock for BioGas? → Energy Crops

- Why are these sources not already being taken advantage of?

New Opportunities (4)

- Why are these sources not already being taken advantage of?

- The answer to this question is almost always universal:

  We would love to use the available BioGas, but balancing its usage with the (inflexible) production is too much of a headache.

Examples of Solutions (1) – BMW[1]

(Article at http://green.autoblog.com/2009/06/11/bmw-expands-landfill-methane-electrical-generation-at-spartanbur/).

- LFG used in production (Dryers in Paint Shop)
- automatic operation
- seamless changeover
- 4 years in service
- 30000+ hours power-ON
- 100's of activations
- not a single outage

Examples of Solutions (1) – BMW$_2$

(Article at http://green.autoblog.com/2009/06/11/bmw-expands-landfill-methane-electrical-generation-at-spartanbur/).

- LFG used in production (Dryers in Paint Shop)
- automatic operation
- seamless changeover
- 4 years in service
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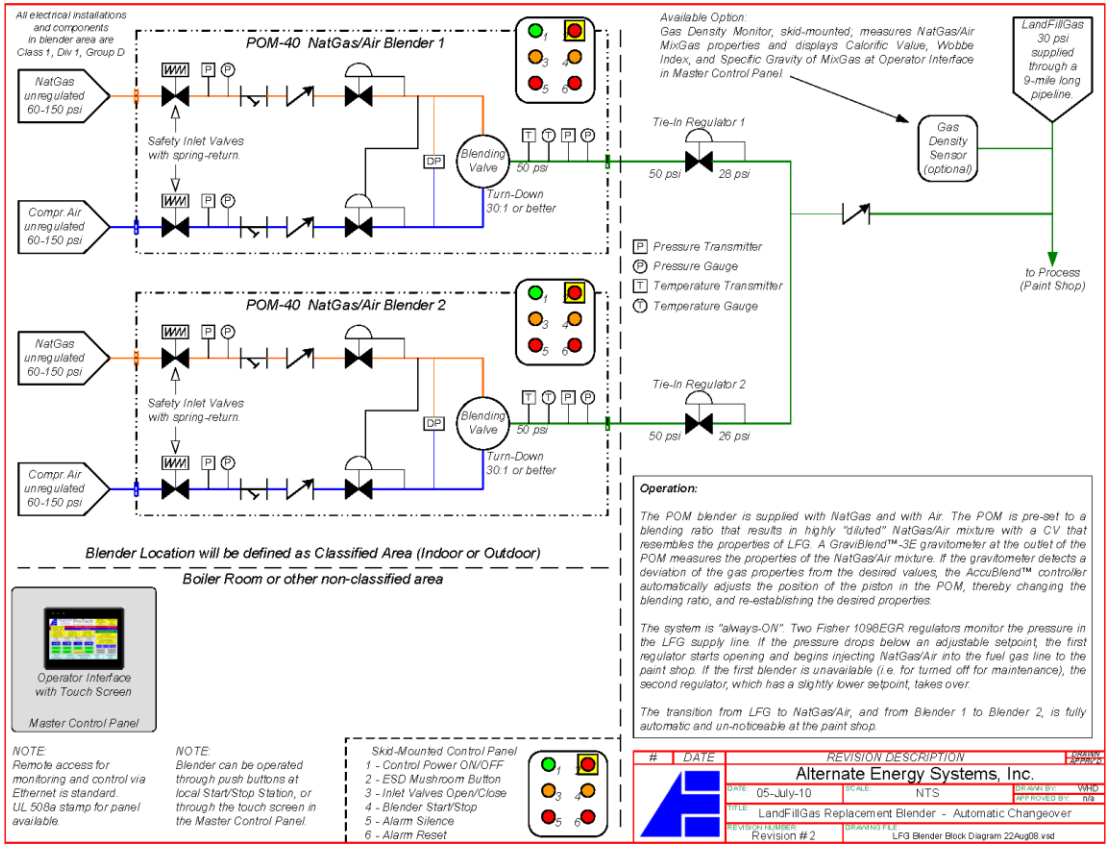
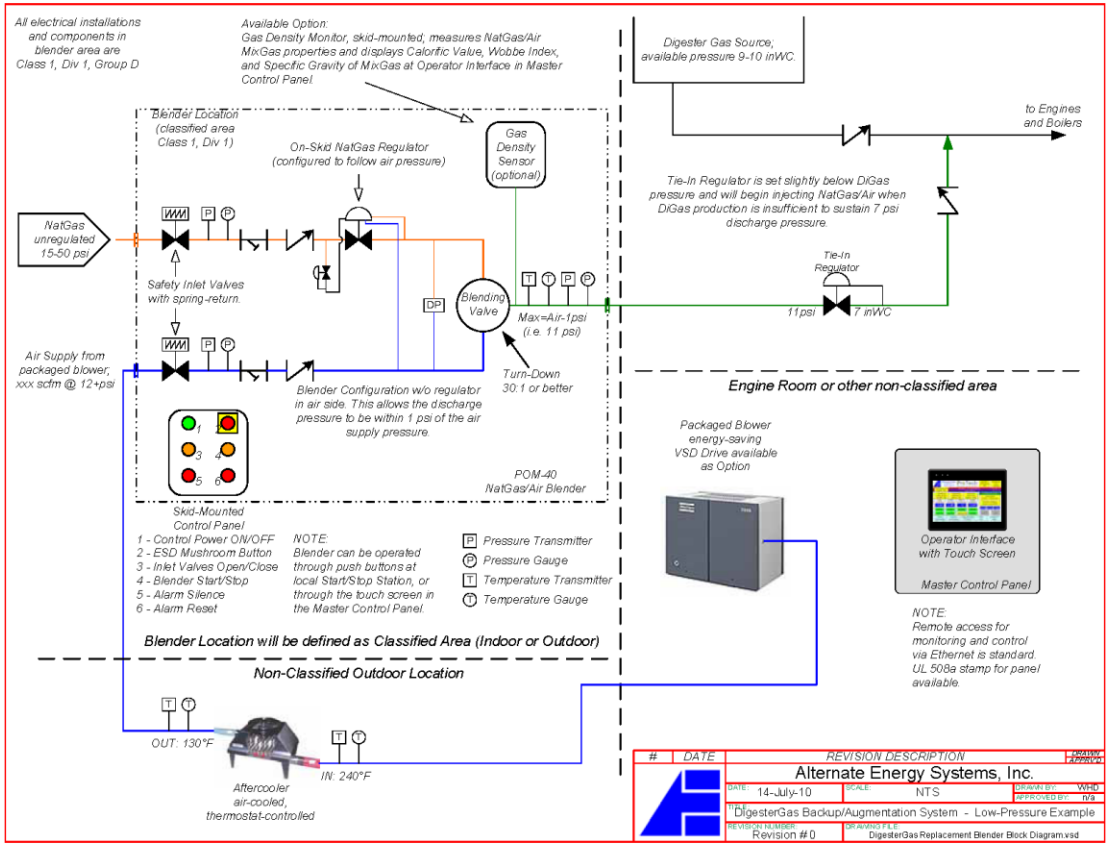


Examples of Solutions (2) - NYC

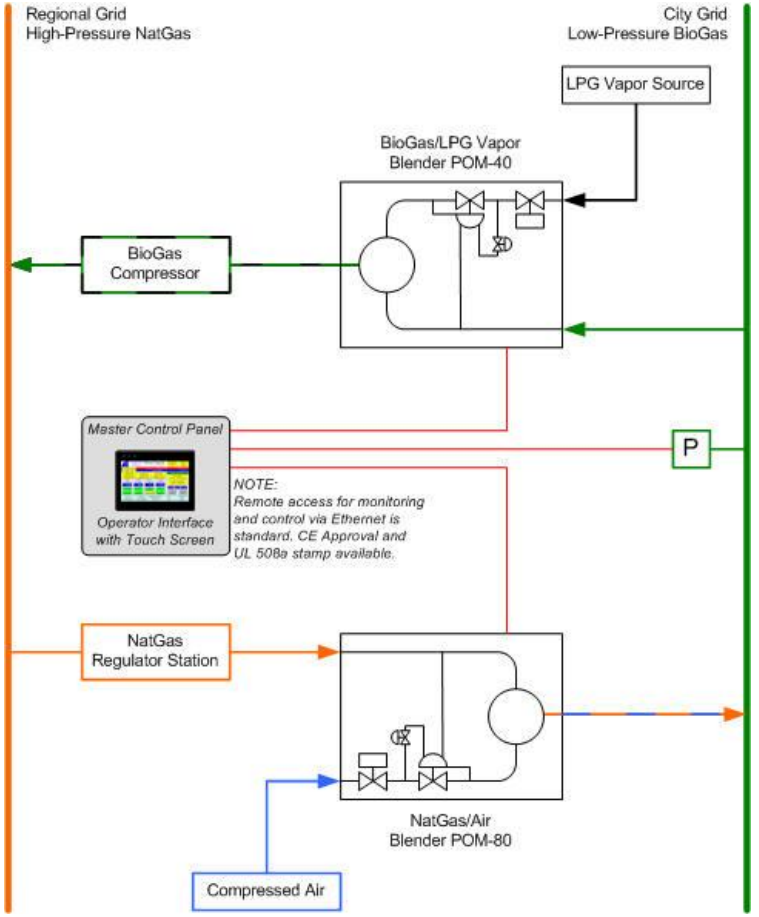
(Article at http://www.nyc.gov/html/dep/pdf/wwsystem.pdf).

- DiG used for generators, blowers, and boilers
- automatic operation
- seamless changeover
- no flare-off of excess gas
- designed for 30-year operation



Examples of Solutions (3) - Germany

- purpose-grown energy-plants (corn)
- excess BioGas is re-injected into high-pressure NatGas grid
- NGA is used to cover peaks
- fully automatic operation



Conclusion

- Highly reliable (and affordable) technology is now available to provide backup/standby/augmentation for BioGas.
- The argument “we would like to use gas from renewable sources, but we cannot rely on a single source for the gas” is no longer valid.
- The availability of easy-to-use NGA blenders offers a tool to reduce the use of fossil fuels for government installations and public utilities, and to increase the use of renewable energy.